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Silicate Magmas under Compression and Confinement
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Upon compression and surface confinement, oxide glasses and melts are expected to be subject to successive structural transitions with multiple densification and confinement mechanisms. Experimental verification of these phenomena remain a major target of glass-melt studies. Here, we provide an overview of the recent progress and insights by solid-state NMR and inelastic x-ray scattering into structures of fluid-bearing multi-component network glasses with varying pressure, composition, and confinement (Lee et al. Rev. Min. Geochem. 78, 139, 2014); Lee Sol. St. NMR. 38, 45, 2010). In contrast to an expected complexity in densification, experimental multi-nuclear NMR results for fluid-bearing multi-component glasses at high pressure demonstrate that the pressure-induced changes in melt structures show a simple trend where the effect composition and pressure can be predicted and quantified with a network flexibility (Lee, Proc. Nat. Aca. Sci. 108, 6847 (2011)]. High-resolution O-17 NMR spectra for binary lead silicate glasses near orthosilicate composition (Pb/Si = 2), as a model system for Mg_2SiO^4 melts, reveal the presence of metal-bridging oxygen (Pb-O-Pb) and thus allow direct quantification of the degree of Mg/Si disorder (Lee & Kim, J. Phys. Chem. C, 119 748, 2015). We also report the structural evolution of andesitic and basaltic melts with varying composition, highlighting the moderate deviation from the degree of Al avoidance among framework cations (Si and Al) and preferential proximity between non-network cations (Ca_{2+},Mg_{2+}) and non-bridging oxygen. Considering all the experimental Al coordination environments available in the literature, together with the current experimental studies, we provide the relationship between the fractions of highly coordinated Al and composition, particularly average cationic potential of non-network forming cations (Park & Lee, Geochim. Cosmochim. Acta, 147, 26, 2014). Finally, as experimental evidence for thickness-induced structural transitions in amorphous oxides is lacking, we report the high-resolution NMR results for the amorphous oxides under confinement where the degree of structural disorder tends to decrease with increasing degree of confinement (i.e., near surfaces) (Lee & Ahn, Sci. Rep. 4 , 4200, 2014).

キーワード: Silicate magmas and melts, High pressure, Nuclear magnetic resonance, Inelastic x-ray scattering, Earth's interior
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